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Locating Corporate R&D Facilities

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Locating Corporate R&D Facilities

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A Research Report from The Conference Board

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Why This Report

Today's highly competitive world economy, coupled with the demise of some industries and the relocation of others to less costly production sites abroad, has elevated the importance of research and development as a prime economic activity in the United States. The aim of this study is to identify and analyze the leading factors and procedures associated with the location of R&D facilities and the conditions and incentives that might stimulate the growth of more R&D investment.

Several areas of substantial concern to both business and government—primarily economic competition (both international and domestic) and the need to promote education and scientific endeavors—prompted the conduct of this study. In recent discussions The Conference Board has had with business and community leaders in a number of medium-sized cities, attention has eventually focused on what communities might do to improve the local economy—mainly, how to attract high-tech industry. Improving the local schools is another major concern. These concerns are translated into a correlation between the need for an adequately trained work force as a requirement for attracting industry, and the capacity of the local education systems, both high schools and colleges, to provide such people.

Such issues as industrial growth, education, science, research and development, local economic development, and the location of industry are part of the continuing research and conference program at The Conference Board. The Board is grateful to the National Science Foundation for its support and cooperation on this project, and to The Small Business High-Technology Institute for its cooperation.

JAMES T. MILLS
President

About This Report

The National Science Foundation, which supplies a major portion of the nation's support for basic research, is vitally concerned with the expansion of the country's R&D base. For that reason, the Foundation supported this Conference Board research into the factors that are considered by corporate decision makers as they select R&D sites. These factors include a combination of economic- and public-policy considerations. Assessing the significance of these issues and their interrelationships was a prime goal of the research project that was conducted with the support and cooperation of the National Science Foundation, the Small Business High Technology Institute, and many of the nation's leading high-technology corporations.

The Conference Board study was conducted using a direct mail questionnaire, plus telephone and personal interviews. From a survey sample of 875 major industrial firms and 200 smaller high-technology-dependent firms, the Board received a total of 318 responses. Of the responding firms, 158 had built new R&D facilities during the past decade. It was the latter firms that provided the primary data base for this report.

Introduction

For most of this century, the United States has held a preeminent lead in research and development. This advantage, coupled with the gains of mass production, provided the U.S. economy with a substantial advantage over its competitors. But as other nations improved their means of production, this edge began to shrink and, at present, the importance of U.S. prowess in R&D is more critical than ever to the nation's international competitiveness.

Within the United States, the advantages to a city, a state, or a region of being the focus of R&D effort are also well-established. R&D facilities become a magnet for many other businesses. They tend to attract higher margin business operations, more skilled and affluent work forces, and to provide a greater stability to the economic base of a region. Community leaders and national policy architects are well aware of the benefits of R&D siting in various areas of the country. The demonstrated advantages gained by Silicon Valley in Northern California, the Route 128 complex in Metropolitan Boston, and the Research Triangle in North Carolina bear witness to the benefits communities can gain from a concentration of R&D facilities.

But while community leaders are interested in and anxious to attract research and development facilities as well as other businesses, they are often unfamiliar with the factors that go into site-selection decisions within the corporate community. The significance of various elements of the infrastructure and the real effect of a potpourri of economic incentives (such as tax abatement and/or deferral, land grants, etc.) are not well understood.

Part 1

Research and Development and Economic Competition

As a general rule, the more a nation invests in research and development the greater its prospects for success in international economic competition. R&D investments presage the development of new technologies and products, and such innovations, when successfully developed commercially, lead to market share-domination.

In the United States, the public and private sectors spent a total of $109.2 billion on research and development activities during 1985. This represented a 12 percent increase over the prior year's investment, but still totaled only 2.7 percent of GNP (gross national product).

Since only $80 billion of the total R&D expenditure was spent by industry, the actual U.S. R&D investment-to-GNP ratio was closer to 1.9 percent. The total U.S. investment was greater than the combined total of expenditures for Japan, West Germany, Britain and France, but the U.S. ratio of R&D investment-to-GNP was not noticeably higher than those of these competing countries. Among the reasons for this discrepancy is the fact that our economic competitors, particularly Japan and West Germany, spend relatively little on defense—relying primarily on the U.S. defense umbrella. In contrast, government R&D funding—$51.5 billion—for defense, space, energy and health programs accounted for almost half of the total R&D funding in the United States. (See Chart 1.)

Recent reports highlight the key role of R&D in international economic competition and the justification for attention to ways to increase R&D activities. The President's Commission on Industrial Competitiveness, in its report *Global Competition, The New Reality*, recommended the creation of a Cabinet-level Department of Science and Technology. It also suggested increased and permanent tax incentives for R&D and the removal of antitrust barriers to jointly sponsored industrial research. In order to increase the stock of scientists and engineers, the Commission recommended increased support for the training of scientists and for university-based basic research. Specifically, the Commission found that:

> "The backbone of technological innovation is research and development and it is those countries with higher growth rates in R&D expenditures that have experienced stronger productivity gains and higher Gross National Product (GNP) growth... Fueled by R&D, technological innovation is vital to America's future because it is the key to productivity advances...Today the role of technology in our everyday lives and in the functioning of our institutions is greater than ever and is still on the increase. In the years ahead, it will be a primary factor in determining our economic vitality, national strength and general well-being."[1]

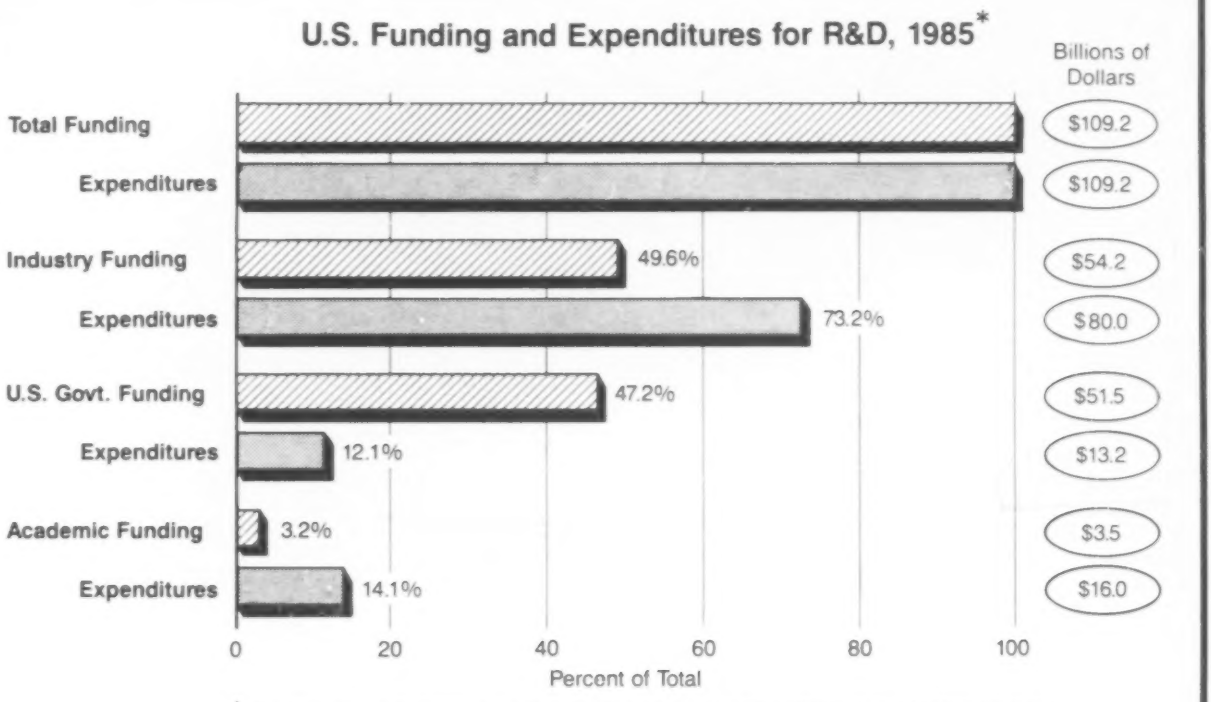
Other studies, such as one conducted by the Center for the Study of American Business at Washington University in St. Louis, have focused on the key forces that "make a period of sustained prosperity in the decade of the 1990's more likely." This study characterized R&D investments as "the basic fuel for innovation and technical progress." It further noted that "investments in research and development constitute an important way in which American industry can hold its own in the face of virulent foreign competition."[2]

Both the President's Commission report and the report by the Center for the Study of American Business make note of a switch from government to the private sector as a leading source of R&D funds. This switch

[1]President's Commission on Industrial Competitiveness, *Global Competition—The New Reality*, U.S. Government Printing Office, Washington, D.C. 1985, pp. 61-93. (passim)

[2]Murray Weidenbaum, Richard Burr, and Richard Cooke, *Learning to Compete: Feedback Effects Of The Non-generic Economy*. Center for the Study of American Business, Washington University, St. Louis, Mo., 1986, No. 73, pp. 17-23.

Chart 1



occurred approximately halfway through the last ten years. (See Table 1.)

The Washington University report concludes that the current trend is beneficial in that almost three-quarters of total R&D expenditures by industry have economic competitiveness as a primary consideration.

Spending by industry largely amounts to converting the advances of basic research into product innovations that can be brought to the marketplace.[3] Government-funded non-defense R&D is still mainly focused on basic research. In fact, nearly 90 percent of all the basic research in the nation is financed by the Federal Government and conducted in the 700 government laboratories and thousands of university research facilities. Only a few industrial facilities, such as Bell Laboratories, perform true basic research.[4]

[3]See, for example, Michael G. Duerr, *Managing Commercial Development*, The Conference Board Report No. 890, 1986.

[4]Regis McKenna, Michael Borrus and Steven Kohn, "Industrial Policy and International Competitiveness in High Technology," *California Management Review*, Winter 1984, p. 16.

Communities Compete for R&D Facilities

For nearly two decades local communities and regions have increased their efforts to attract high-tech industries and industrial R&D facilities. High-tech industries by their very nature—and by Business of Labor Statistics definition—are research driven.[5] While the term "high-tech" is applied generically to electronics and computer manufacturers, actually the largest number of high-tech companies are found in the chemical industry.

Local economic development practitioners have favored such facilities because of the "clean" (non-smokestack) image and the alleged glamor associated

[5]An industry is classified as high-tech by the Bureau of Labor Statistics if it satisfies one of three criteria: (1) the proportion of its workers in scientific and technical fields is as least one-and-a- half times the average for all industries; (2) the ratio of its R&D expenditures to its net sales is at least twice the average for all SIC-code-designated industries; and (3) the proportion of technology-oriented workers relative to total employment in the industry is equal to, or greater than, the average for all manufacturing industries (6.3 percent) and the ratio of R&D expenditures to sales is close to or above the average for all industries (3.7 percent).

with high-tech, as well as the proven advantages that communities with such a facility have enjoyed. The consulting firm of Booz-Allen and Hamilton, in a report prepared for the New York City Partnership, summarized these advantages as providing:

> "a fertile climate for new products, processes and services. . .and contributing to the emergence of entirely new high-growth industries. A robust and dynamic high-technology sector can also help ensure the continued health of a city's existing industries, diversify its business mix and industrial base, generate new employment and foster an entrepreneurial environment that acts as a magnet to attract new companies and resources.[6]

In assessing recent changes in the economic development profession, Norton Berman, a business location consultant, noted that many states and localities are ". . .underwriting the development of new industries based upon the commercialization of research in areas where their university and industrial research capabilities are strong and competitive. . ." Berman identifies such consortia—the Ben Franklin Partnership in Pennsylvania and North Carolina's Research Triangle—as examples of the new ". . .government-industry-educational consortia, which may eventually rival the military-industrial complex in its pervasive influence."[7]

For example, successes of the research-based economic-development center at the Research Triangle (Raleigh, Durham and Chapel Hill, North Carolina) have spurred other nearby cities (e.g., Winston-Salem, Greensboro and High Point, North Carolina) to develop programs targeted at attracting high-tech industry. In Winston-Salem, a new biotechnology "incubator" has been created through the cooperative efforts of local government, the business community, and the Bowman Gray Medical School at Wake Forest University. In Allentown, Pennsylvania, local economic-development specialists, with assistance from the Ben Franklin Partnership, created a "high-tech incubator" built around the research capabilities of Lehigh University.[8] These incubators and research parks are built upon the premise that new R&D facilities will benefit from access to university-based scientific talent, and that support services and reasonably priced land and building facilities are available within the community or region.

Table 1: Real Outlays for R & D, 1975-1984 (dollars in billions)

Year	Federal Government	Private Industry	Total[1]
1975	$16.6	$14.5	$32.2
1976	18.9	16.8	37.1
1977	20.5	18.6	40.5
1978	22.3	20.9	44.9
1979	24.7	24.0	50.6
1980	27.2	28.2	57.4
1981	30.8	32.8	65.8
1982	34.5	37.7	74.5
1983	38.2	42.7	83.3
1984	42.9	47.9	93.4

[1]Includes universities and nonprofit institutions. Note: Actual data have been deflated by GNP price deflator, 1972 = 100. Source: National Science Foundation.

But the relationship between many communities and new R&D facilities is still somewhat tenuous. These newer R&D facilities have not had the benefit of years of government-supported research that helped to spawn the high-tech centers surrounding such renowned universities as MIT and Stanford. Nonetheless, a combination of managerial and financial incentives, plus access to university talent, does provide these new consortia with the assets needed to attract R&D investments. And, of course, the local economic developers did not depend solely on R&D investments. While they were at it, they also sought investments from "low-or mid-level tech" industries and nontechnical business to help fill up the newly created research and development parks.

The Growth of R&D Facilities

During the early 1980's, R&D, which was increasing at an annual rate of 6.5 to 7 percent, could be classified as a growth industry. But, as much of the impact of increased government spending for defense research has

[6]Booz-Allen & Hamilton, *High-Tech New York*, A Report to the New York City Partnership, 1986, p.12.

[7]Norton L. Berman, "Trends in Economic Development," *Economic Development Commentary*. National Council for Urban Economic Development, Spring, 1986, p.15.

[8]Leonard Lund, *Issues in Economic Development: Stimulating Local Leadership and Resources*, The Conference Board, Research Bulletin, No. 175, 1985.

Table 2: New R&D Facilities (by Industry) 1975-1985 (N = 158)

SIC Code	Industry Description	500 Employees or more	Fewer than 500 Employees	Total Companies
28	**Chemicals**	**29%**	**8%**	**23%**
283	Pharmaceuticals	7	5	6
281	Inorganic Chemicals	7	3	5
73	**Business Services**	**3%**	**38%**	**11%**
739	R & D Laboratories	2	28	8
737	Computer Services	1	10	3
36	**Electrical and Electronics Machinery**	**10%**	**15%**	**11%**
362	Industrial Controls	5	0	4
367	Electronic Components	0	15	4
35	**Machinery, ex. electric**	**8%**	**5%**	**9%**
357	Office & Computing Eqpt.	3	5	3
38	**Scientific Equipment**	**7%**	**10%**	**7%**
384	Medical Equipment	4	3	4
381	Eng. & Sci. Instruments	0	5	1
37	**Transportation Equipment**	**4%**	**3%**	**5%**
371	Auto Equipment	3	0	3
372	Aircraft Equipment	3	0	3
	All Other Industries	39%	21%	34%

already been absorbed, such growth has now slowed. In 1986, research and development activities, as a percentage of sales and operational costs per professional employee, are projected to show no marked increase, and capital spending for new R&D facilities will be flat.[9]

Some observers have pointed out that the amount of construction for new R&D facilities during the past decade has been relatively modest, even given the increase in spending. Martin D. Raab, a leading designer of R&D facilities, estimated that 80 percent of the industrial research laboratories currently in use are more than ten years old, and nearly 45 percent are more than twenty years old.[10]

However, nearly half of the 318 companies responding to The Conference Board's survey report having built additional new R&D since 1975, and 80 percent of these being added since 1980. A substantial number of these—one in four—are firms with fewer than 500 employees, and more than 90 percent of these smaller companies are engaged in R&D services and high-technology industries.

Not surprisingly, the largest segment of the companies building new facilities, almost one-third, are in the R&D defense services category, and are engaged primarily in research on military hardware and systems. Many of these do not produce a manufacturable product: They perform research tasks for the Department of Defense or as subcontractors for major weapon-systems producers.

The larger companies surveyed (those with more than 500 employees) are principally in the nonconsumer or industrial sector (51 percent); 32 percent are consumer goods industries, and the remainder are in defense-related industries.

The firms surveyed are active in 57 different industrial product and service categories at the three-digit SIC (Standard Industrial Classification) level and 23 at the two-digit level. The largest major category represented is the chemicals industry with pharmaceuticals the largest portion of that industry. Among the smaller firms surveyed, business services—and its primary subcategory research and development laboratories—led the list. (See Table 2 for distribution of new facilities by industry and company size.)

[9]"Annual R&D Trends Survey of The Industrial Research Institute," *Research Management*, January-February, 1986, p. 12.

[10]Martin D. Raab & George L. Sutherland, "Top Management Gets Into Planning Strategy for New R&D Facilities," *Research and Development*, March 1984, p. 142.

Emphasis On New Products and Development

The companies surveyed were questioned as to the importance of the R&D function to the company's success and the kinds of activities conducted at the new R&D facilities they had constructed. Of the smaller firms, one-third said that the new facilities were totally committed to new product development. By contrast, only one in eight of the major firms commit the new facilities entirely to new product development. There is, of course, some ambiguity in firms' descriptions of their "product development" activities. In some instances, refinements of existing basic research are necessary before product development can begin. In other instances, the "new" products that firms refer to are, in reality, line extensions or modifications of existing products or product groups. Three-quarters of the firms surveyed describe themselves as "heavily dependent" upon research and development and almost half of all the firms believe their dependence is of "critical importance." Among the smaller companies studied, the importance of R&D is even more pronounced: Sixty percent of these firms describe themselves as critically dependent on R&D, and another 28 percent as "heavily dependent on R&D." In fact, only 2 percent of the firms responding believe that they have only a ' slight reliance" upon research.

Part 2

Location Criteria

An analysis of The Conference Board's survey data shows that two major considerations must be taken into account in determining the criteria that companies depend on in locating R&D facilities. The first involves the firm's organizational structure—that is, the degree of autonomy provided operating divisions, the ways in which major product groups are structured, and so forth. The second consideration has to do with the "needs" of the company's technical staff and how best these needs can be met. For example, when organizational considerations are of paramount importance—firms say they are likely to choose locations that are "near headquarters" or "near a manufacturing plant." But when the company's emphasis is on the technical staff itself—that is, when human resource considerations are of paramount importance—firms are much more likely to give as reasons for a siting decision such factors as "near a university or research center," "in a community with good quality of life," or, more specifically, "whether there's good access to needed scientific or technical personnel."

In the case of smaller firms, a third factor—cost—is sometimes of primary concern. The costs of acquiring land, buildings, equipping laboratories, and even key managerial personnel's costs of commuting to and from the facility considered of prime significance by these companies.

Ranking The Locational Factors

While the companies responding to this survey often report that several factors are equally important in their site-selection decisions, three primary considerations—selected from a list of twenty—appear in nearly all site-selection choices. These are:

(1) The need for a continuing supply of scientific and technical personnel;
(2) The desire to be near company headquarters;
(3) The desire to locate in a community that has a "good quality of life" and adequate R&D-supporting infrastructures.

The executives questioned say these factors are often closely interrelated. For example, the director of research for one major consumer products company added this perspective: "A good quality of life and getting the right kind of talent go together because people attract people." A sizable minority of the respondents had difficulty selecting a single factor as most important in the site-selection decision.

Despite such reservations, it does appear that access to an adequate supply of scientific and technical personnel is the single most important requirement for most companies. This supply of personnel is assured by two principal sources: the existence of other high-tech companies in the community or region and/or the presence of universities specializing in scientific and technical disciplines.

A small number of firms, however, go in exactly the opposite direction from that of the majority. These firms do not choose to be in areas where there are a number of other technical companies. They report that such localities experience wage inflation because of the competition between companies, and that they do not want to be engaged in a bidding war with competitors for skilled personnel. Besides, they say, if the community they select has an excellent quality-of-life profile, they can probably attract engineers and scientists from other parts of the country to live and work there.

Staying Near Home Base

Over half of the firms questioned say that they have a strong desire to locate R&D facilities reasonably close to corporate headquarters. "Reasonably close" is a description that can cover a range of geographic dimensions. For some firms it means in an adjoining building;

for others, it means within the same county. For most firms, a distance of 30 miles or more is the maximum range in describing a site as "reasonably close to headquarters."

Numerous reasons are given for the urge to locate near company headquarters. In general, these boil down to convenience. Company managers need to meet with scientific and technical personnel on a face-to-face basis. Remote locations for R&D facilities are believed to reduce the ability of scientific and technical personnels to keep in touch with the marketplace. Increasingly, firms want their R&D effort closely integrated with their marketing effort. Distant locations, which make it practically difficult for marketing and managerial personnel to visit regularly with R&D specialists, are thought to impede company efforts to integrate research and development with marketing and product planning.

The vice president of research for one consumer products firm points out that his technical staff needs constant feedback on consumer reactions to new product prototypes. He believes that if their R&D facility was located far from headquarters, such a feedback would be restricted—since most of it is generated by the company's marketers.

For many firms, there is already a close geographic link between corporate headquarters and the firm's primary manufacturing facilities. Often, these are located in the same community or region. Corporate-level managers and administrators in such companies like to be able to get to their manufacturing units with relative ease. As these companies go about selecting sites for R&D facilities, they are overwhelmingly inclined to select nearby communities.

In still other instances, companies find that the R&D function serves a variety of company products. If the product groups are all situated in a particular region, or even within a single community or state, it makes sense to locate the R&D facility there as well. In an earlier Board study on the location of corporate headquarters, historical connections or identifications with a particular community were found to be a leading factor in companies' site-selection decisions and this influence continues to be a major one.[11]

Locating Near Manufacturing Sites

Several of the companies interviewed point out that there is very real need for research and development operations to be located close to their manufacturing operations. They indicate that the nature of their manufacturing operations is such that product design, and particularly the development of product prototypes, requires close cooperation and coordination between manufacturing facilities and R&D personnel.

Table 3: Leading Site-Location Requirements (N = 158)

Requirement	Rank			Total-First 3
	First	Second	Third	
Supply of scientific personnel	16%	19%	22%	57%
To be near headquarters	39	7	6	52
Quality of life	4	14	22	40
To be near university or research center	5	14	5	24
To be near manufacturing	10	8	5	23
Reasonable property cost	6	6	9	21

Other Location Factors

Increasingly, additional—often hard to define—factors influence company site selections. When the site chosen requires many of the staff to relocate, companies discover that they must consider factors that were not previously weighed. For example, a recent survey of MBA's found that mid-level managers are vitally concerned with the job opportunities for spouses in cities and regions to which they might be relocated. Some are also interested in alternative job possibilities, should they decide to leave their present employer.[12] Thus, communities in remote locations have a built-in disadvantage because of their smaller employment base.

While site-and-building-acquisition costs do not lead the list of decision factors, there is little doubt that they do play an important part in many companies' choices. Land-acquisition and building costs do differ significantly among regions of the United States, and several of those questioned point out that these variations have been important in the recent past—in selecting sites in the South and West where, until recently, land and acquisition costs have been lower than in the Northeastern and Middle Atlantic states.

[11]Leonard Lund, *Factors in Corporate Location Decisions*, The Conference Board, Information Bulletin No. 66, 1979.

[12]Norton Berman, p.15-16.

The Weighted Decision

As indicated, the survey respondents were asked to rank the three most important site-selection factors, and those rankings are summarized in Table 3. But it is also possible, to obtain a weighted rank by assigning weights of three to the first choices, two to the second choices, and one to the third choices. This latter system was used to weigh all of the site-location factors cited by the respondents. Using such an analysis, Table 4 shows that being near company headquarters edges out a good supply of scientific and technical personnel as the leading factor for this sample of respondents.

Variations By Company Size

While large firms and their smaller counterparts generally select the same location factors as being of prime significance, there are some variations in practice, as shown in Table 5. One of the most important of these is the desire of smaller companies to be located near university centers. Interviews with principals in these smaller firms confirm the common-sense notion that such firms require greater external support by technical consultants and life-of-project specialists. University professors and graduate students can often provide these kinds of services. On the other hand, the larger companies are more likely to consider proximity to either headquarters or manufacturing installations.

Another difference between larger and smaller companies is evident in the number of considerations among siting requirements. Smaller companies tend to choose from a much broader list of options. Only 63 percent of the small companies chose from among the six major categories shown in Table 5, but 64 percent of the larger firms chose from just two of these categories.

Table 4: Site-Location Requirements, by Rank (Percent of Weighted Response)

Requirement	Rank	Percent of weighted response[1]
Near headquarters	1	23%
Scientific, technical personnel	2	18
Quality of life	3	11
Near manufacturing	4	8
Near university or research center	5	8
Reasonable property costs	6	6
CEO's preference	7	5
Good business climate	8	2
Monetary incentives	9	2
Good labor climate and supply	10	2
Meets environmental requirements	11	2
Adequate transportation	12	2
Cooperative local government	13	1
Water supply and energy	14	1
Close to similar industries	15	1
Security considerations	16	1
Access to critical materials	17	1
Low taxes	18	1
Distant from competitors	19	1
Weather	20	0
Other (not specified)		5

[1]Details do not add to total because of rounding.

Table 5: Site-Location Requirements, by Size of Company

	Under 500 Employee (N = 40)				More Than 500 Employees (N = 118)			
	Ranking				Ranking			
Requirement	First	Second	Third	First 3	First	Second	Third	First 3
Scientific personnel	5%	23%	33%	60%	21%	18%	18%	57%
Near headquarters	25	3	5	33	43	9	7	59
Quality of life	10	13	20	43	2	15	23	40
Near university/research center	0	25	5	30	7	9	5	21
Near manufacturing	10	3	3	15	9	9	6	24
Reasonable property costs	13	8	8	28	3	6	9	19

Table 6: Site-Location Requirements, by Industry Category (N = 158)

Requirement	High-Tech Ranking First	Second	Third	Total-First 3	Other Manufacturing Ranking First	Second	Third	Total-First 3	Nonmanufacturing Ranking First	Second	Third	Total-First 3
Scientific personnel	13%	0	44%	57%	17%	21%	20%	58%	17%	23%	20%	60%
Near headquarters	19	6	6	31	43	9	5	57	37	0	10	47
Quality of life	13	6	38	57	1	15	20	36	13	13	20	46
Near university or research center	6	44	0	50	6	7	7	20	0	17	0	17
Near manufacturing	13	6	0	19	9	10	6	25	3	0	3	6
Property costs	13	0	0	13	5	5	8	18	3	13	17	33

Variations by Industry

It is also possible to analyze the data by dividing the survey respondents into three major industry categories—high-technology manufacturing, other manufacturing, and service or nonmanufacturing firms. When these divisions are made, the survey data show that high-tech companies, particularly the smaller ones, place a greater overall reliance on quality-of-life factors and proximity to universities than do the other categories. Equally interesting, the high preference for a university location is the only second ranking requirement of consequence. (See Table 6.)

The relatively high ranking of quality-of-life and university proximity for the smaller companies (Table 5) and also for the high tech companies (Table 6) emphasizes the importance of the availability of scientific personnel as a site location factor. Conversely, being located in a good community (including a university) was a leading factor among scientific and technical professionals in choosing a company for which to work.[13]

Siting Choices: Practice versus Conventional Wisdom

The survey results tend to disprove some of the popular ideas about why firms locate in particular regions. Not everyone, for example, is flocking to the Silicon Valley to locate high-tech facilities. While Silicon Valley, the Boston suburbs, and the Research Triangle of North Carolina continue to attract research-based and high-tech companies, many other areas, mostly on the east and west coasts, are competing successfully for such installations.

The survey responses indicate that, for small companies particularly, nearly half of all the new installations were located in the Boston area, in the immediate environs of Washington, D.C., or in the San Diego-Los Angeles corridor. The pattern was somewhat different among larger firms, which located their new R&D facilities among 34 separate states. But the coastal regions still gained the major portion of the facilities. California had the largest number with 17 new laboratories; Pennsylvania had 14; New Jersey, 12; New York, 11; and Massachusetts and Michigan, 10 each.

Another factor cited by some observer, in explaining site selection decisions focuses on "corporate culture."[14] The reasoning is that companies with highly centralized management will prefer nearby sites for R&D facilities, whereas those with a decentralized culture will select more distant locations. There is also the theory that having corporate R&D facilities too close to corporate headquarters might produce a dampening effect on research creativity. But such theories are hard to substantiate. More practical considerations, such as the location factors previously cited, are of such overwhelming importance that the impact of corporate culture seems to be canceled out. In a few cases, research directors complain that the R&D function is not as highly valued as it should be by the corporate hierarchy. They do discount, however, any loss of creativity as a result of proximity to headquarters.

[13]Norton Berman, p. 15.

[14]The concept of corporate culture is being broadly used in current management discussion. For an example of the effect of culture changes in a high-technology company, see W. Brooke Tunstall, "Disconnecting the Bell System: An Insider's View," in Melissa A. Berman (Ed.) *Corporate Culture and Change*, The Conference Board, Report No. 888, 1986, pp. 36-39.

Relocating an R&D Company

In general, there are relatively few differences between locating a company's R&D facilities and relocating an entire R&D-based company. If there is a difference, it lies in the relative importance of the site requirements.

A visit to a small research-based high-tech company, located in Cambridge, Massachusetts, highlights the impact of some of the requirements that determine where a company chooses to relocate—once the first location is found to be unsatisfactory.

The XXX company is a small, privately held, high-tech firm specializing in artificial intelligence research. The company employs 80 people, 65 of whom are engaged in research and development activities. Originally, the company chose a location in a suburb of Boston that offers many of the qualities a new company usually looks for in a suburban location—accessibility, reasonable cost, adequate space, and room for expansion. Being located in the Boston area, the company could tap a large pool of scientific talent and enjoyed the advantages of being near a city long considered a choice community for intellectual stimulation and cultural amenities. In addition, there are a number of major universities nearby. Many of the firm's key researchers have graduated from the Massachusetts Institute of Technology and have retained some relationship with MIT—although there is no formal connection between the university and the company.

But soon after the company located in the suburbs it began to experience location-related difficulties. It was evident that the suburban location could not fulfill some needs. Company executives found that the nature of their firm's research function, as well as the unusual working habits of the researchers, required twenty-four-hour, seven-day-a-week accessibility. Many of the staff had extensive travel schedules and travel requirements, also creating a need to be near a major airport. In addition, because of the nature of the company's dependence on computers, a completely reliable source of electric power was essential. The suburban site did have power "spikes" (fluctuations) and the interruptions had an impact on company research.

All of these factors added up to a decision to relocate in downtown Cambridge. While the ability to expand is somewhat restricted, the other advantages of the Cambridge location outweigh the disadvantages encountered in the suburban site.

At one point, during the relocation-decision process, the company had also considered Princeton, New Jersey, as a possible location. But Princeton was eventually ruled out in favor of Cambridge, primarily because of the immediate access that Cambridge offered to Logan Airport and—quite possibly—because of the historical connections between the research staff and the local universities.

While companies may state what they believe should be the selection criteria used to locate their R&D facilities, these criteria do not always match actual company practice. For example, 42 percent of the new research facilities described were separate establishments that conducted only research and development; 31 percent were linked to headquarters, and another 15 percent to manufacturing facilities— while the remainder were tied to various other company operations. Almost a third of the firms report a linkage to headquarters, but say also that the R&D facility is linked to manufacturing. In these cases the companies have clustered several facilities in the same location or, in a few instances, may have a single site for all of the company's operations. And although companies laud the desirability of linking up with a university and locating close to such a facility, only 2 percent of the companies report that they had actually located one of their research facilities in a research park with close geographic and professional links to a nearby university.

Japan has had difficulties in getting companies to practice what they preach as far as R&D site location is concerned. For example, the Japanese Ministry of International Trade and Industry (MITI) invested more than $5 billion dollars in Tsukuba, Japan's science city, a special R&D facility located northeast of Tokyo. This complex houses 51 government and private research institutes as well as two universities. Yet fewer than thirty industrial firms have chosen to locate their laboratories there, and only one major pharmaceutical firm has established its central research facility at Tsukuba.[15]

[15]Gene Gregory, "Japan's Science City," *The Futurist*, January-February 1986, p.38.

The Effect of Community Educational Levels

The educational level of citizens in a particular city or region is a locational factor implicit in two of the leading locational requirements—proximity to universities and high quality of life. There is little doubt that scientific and technical personnel want continued access to institutions of higher learning. Some of the most favored R&D sites have this kind of access for post-graduate professional training as well as for broad educational goals. One site specialist, describing this situation, says:

> "Both California's Silicon Valley and Boston's Route 128 corridor are involved, in part, because of their proximity to major universities... [they] present the opportunity to mold courses and degrees to fit company needs. Even more important are the hefty research budgets—both government-funded and privately endowed—of many technical schools which, more and more are contributing industry research programs and, in some cases, underwriting entire projects. This arrangement particularly helps small entrepreneurial firms that don't have much financial backing; but larger established companies are also taking advantage of this 'technical infrastructure.' Providing companies with properly educated prospective employees has become so important that many schools are aggressively conforming to the needs of nearby industry, adding relevant courses, and scouring private and federal sources of research funds."[16]

Those charged with the responsibility for site-location decisions seem to have a particular awareness of the educational attainments present in the various communities they are considering. One manager cited the fact, for example, that one in five male adults in the Princeton, New Jersey, area held a doctorate-level degree. And others were able to point to the percentage of college graduates in communities they were considering for R&D site location.

Regional development specialists, seeking to attract R&D facilities, are at a loss as to how to upgrade the educational attainments of an entire region quickly. Improvements in the educational system help, of course, but they cannot provide the mass infusion of highly educated personnel that companies are seeking. Like good weather, or adequate water supplies, these seem to be characteristics that are not readily transferable, the managers point out. One site specialist, looking at this situation, reports:

> "Plants can be built anywhere. Money is transferred instantly throughout the world. Communication is instantaneous, allowing management to disperse facilities to meet changing economic conditions. The only production factor that is relatively immobile and, therefore, the one upon which the future of our national economy and standard of living depends, is our people. Their skills, their capacities to work together, their understanding of the technological future and its application to our industries — in other words, their education—these will be tested to the fullest. Just as the three most important factors in the sale of real estate are said to be location, location and location, the highest priorities of economic development in the future are likely to be education, education and education."[17]

[16]Mark L. Goldstein, "Choosing the Right Site," *Industry Week*, April 15, 1985, p. 58.

[17]Norton Berman, p. 16.

Part 3

Who Makes the Decision?

One major goal of the Board's research project was to determine who makes the site-selection decision. Predictably—especially in major corporations—the decision is made by a group and involves a team of decision makers. The survey finds that the leading role on this team is usually played by the corporate head of research.

In smaller firms, the chief executive officer may make the location decision, largely unaided by staff input. The CEO will decide whether to build the new facility, where to locate it, and even what form the facilities shall take. This reflects the fact that in smaller companies the CEO is often the de facto head of the firm's research and development effort. In larger companies, staffed with vice presidents for research and development, top management usually delegates site- selection responsibilities to such functional executives while maintaining an overall control.

Initiating the Location Decision

The survey respondents report that the decision to construct a new research and development facility often tends to follow a predictable pattern. Company executives, usually led by the research and development director, make a determination that the present facilities are either too small, too old, or not fitted to the company's existing product-development effort. At this point, management wrestles with a decision as to whether to renovate or expand existing facilities instead of building a new one.

The survey data show that in nine out of ten cases the most senior executives in the company—the chairman, CEO, and president—are closely involved in the decision as to whether or not to build a new R&D facility, and where this facility (if built) should be located. In only 2 percent of the companies studied was the initiation and location decision left to division, group or regional management. In larger firms, because they most often have a functional executive fully concerned with R&D management, this executive is the one most likely to initiate the decision. (See Table 7.)

The total number of executives involved in the location decision itself was not radically different among large and small companies. In small firms, the number of executives closely involved ranged from two to five; in larger firms, the number directly concerned ranged from three to six.

The Role of The Project Team

Companies attempt to develop new R&D facilities that are flexible enough to meet future, as well as present, demands. To accomplish this goal, they often put together a project team that will provide a maximum amount of insight into the planning needs of the R&D function. Lab-design consultants often suggest that the location decision be made through the consensus of such a project team. In order to construct such a team, they suggest assembling the following group of individuals:

- *The company research director,* who understands fully the firm's scientific activities and regulatory requirements it is subject to, and who will have the responsibility for implementing the firm's R&D plan.

Table 7: Who Initiates the Location Decision, by Size of Company

	Under 500 Employees (N = 40)[a]	Over 500 Employees (N = 118)
President or CEO	73%	19%
Corporate R & D Head	13	52
Division manager	2	9
Division R & D Head	2	10
Combination of above	8	5
Other	2	4
No answer	0	1

[a]Details do not add to total because of rounding.

- *The executive in charge of the company's central engineering department*, who will determine the architectural and engineering requirements needed for a new facility and evaluate proposals from consultants and architects.
- *The corporate chief financial executive*, who will be responsible for monitoring R&D expenditures, and who will help evaluate the financial options presented in the construction phase.
- *The corporate legal counsel*, who will provide continuing advice on the contractual arrangements relating to the acquisition of land, buildings, construction, and so forth.
- *A corporate facility planner or programmer*, who has an intimate knowledge of the company's communications systems, space requirements, and the design implications of alternative office and lab layouts.
- *The company-community affairs or public-affairs officer*, who may be required to help address community concerns that arise out of the acquisition and construction of the new facility.[18]

The use of project teams, consultants say, helps manage what is most often a one-time task. Eighty percent of the nation's R&D facilities are more than ten years old, and the 6,000 plus corporations that maintain such facilities operate, on average, only two establishments each. Obviously, the need to construct new facilities and to make location decisions occurs infrequently. Thus, there is little need for developing in-house expertise in this area.

The Site-Selection Process

The term "site selection" is used by many firms to indicate not only the process of choosing a particular site but also the acquisition or purchase process. Among the companies studied, the site-selection process is most often handled by internal staff. In large firms, 72 percent of the companies utilize either in-company real estate specialists or assign the job to company task forces. In smaller firms, 80 percent of the companies choose to do the job themselves. Only 3 percent of all the firms surveyed rely primarily on outside site-selection consultants. There may be a number of reasons for this. To begin with, location near company headquarters is a given for many of the companies studied, so the number of site options is necessarily limited. Second, several of the firms questioned say they already had vacant land, acquired as part of the company's overall real estate-planning process, which was available for use as an R&D site.

The director of research for a major pharmaceutical company explains: "We have a program of long-term property acquisitions involving property around our research complex. So when we decide to build a new building we already have the property needed." Some of the variations between large company and small company practice are predictable: In smaller firms, the personal wishes of the chief executive officer, or founders of the company, can assume overriding importance. For example, in one small high-tech firm a company spokesman recalls: "The co-founders chose a place they wanted to live in, then they found a site for the firm within that area. Even though we are in a semi-remote location, we have become a flourishing high-tech company and essentially self-sufficient."

In a few cases the companies were under pressure to make rapid moves. One firm noted that time and cost were of overriding importance: "We needed instant availability of an empty building that could be easily converted to meet our needs." In other companies, factors such as employees' attitudes toward relocation—and which sites would be most favorably viewed by employees—as well as the supply of reasonably costed housing, and even the issue of traffic congestion, played critical roles in site selection.

A Quiet Process

Companies usually conduct their search for an R&D location in private. In the overwhelming majority of cases, the survey respondents report, they try to avoid generating open competition among various communities seeking an R&D facility, and so public announcements are seldom made prior to the acquisition of a property.

Sometimes, smaller firms are more likely to be open and candid about their site search. Often, they require some kind of financial assistance and, therefore, may work closely with local banking institutions or public- or private-development organizations.

For most, it appears that the site-selection process and the acquisition of property go relatively smoothly. Only one in twenty companies reports difficulty in acquiring a new site. The most common complaints involving acquisition center about zoning issues, the difficulty of employee relocation and, in a few cases, community resistance to the construction of a new facility. The firms are apparently able to get the help required to staff the new facility since only one firm reported it had difficulty recruiting qualified people to work at a new location.

[18]Martin D. Raab, George L. Sutherland, p. 145.

The Issue of Incentives

As already noted, some companies do choose locations on the basis of the cost of property or because of assistance provided by local business-development agencies. Among the smaller firms studied, about one-third sought aid from local government agencies. A slightly larger group (38 percent) of the major firms also sought and received such assistance.

With strong competition among cities to lure new businesses—particularly those in high-tech industries—companies are finding that a variety of incentives are offered to locate R&D facilities. Financial incentives, in the form of tax abatement, direct grants or loans, the use of financing instruments (such as industrial revenues bond), and so on, are among the aids offered. The study finds that over 60 percent of the assistance given to companies in this sample comes in the form of financial assistance.

But companies also benefit from logistical aid. This may include the assembly of several parcels of land into a single site, expediting desired changes in zoning, and the improvement of certain infrastructure elements such as roads, sewers, and the like. In most cases, the firms report, there is a more-than-abundant source of energy. And environmental constraints have not proven to be a major obstacle to the location of new R&D facilities, the firms say.

How Much Difference Does Assistance Make?

The companies surveyed were asked to rate the importance of various incentives in choosing a particular site. Respondents were asked to categorize the degree of importance as "critical", "very helpful," "helpful," "somewhat helpful," or "unnecessary." In this portion of the survey there was a very marked variation between large and small firms. More than half of the smaller companies described such incentives and assistance as "critical" or "very important," and only 27 percent found such assistance either "somewhat helpful" or "unnecessary." By contrast, 60 percent of the larger firms said that such incentives were either "somewhat helpful" or "unnecessary;" And only one in five of the larger firms considered these incentives to be of critical importance.

The Role of Incubators and Research Parks

Among the site options that both large and small firms can consider is the use of "research parks." Some of these are university-based or connected, while others are established by local entrepreneurs or economic-development agencies. Typically, the park is a "business incubator" in that it may provide rental space for relatively small enterprises, offer shared office services, and, in some cases, management consultation to assist embryonic businesses. These parks are conceived as a means of fostering the establishment of new small businesses and as an important avenue for creating new jobs.

According to a recent study conducted for the Economic Development Administration of the U.S. Department of Commerce, there were about 125 business incubators operating at the beginning of 1986, and it was expected that an additional 100 might open during 1986.[19] The study found that two types of businesses were represented equally in research parks—regardless of their sponsorship (university, development agency, or entrepreneur): These are light manufacturing companies (usually with a large high-technology component) and professional service firms.

Only in the university-sponsored facilities—which were heavily subsidized by local or federal funds—were a substantial number of the tenants in the research parks actually engaged in research and development. In the university-connected parks 36 percent of the tenants were classified as R&D firms. Nonetheless, the university-affiliated research parks and university-business consortia were thought to play an important role in providing new jobs and generating local economic activity. In addition, they had other unique characteristics. The author of the EDA study points out that:

> "Recently, universities have begun to seek new markets.
>
> In particular, state-supported universities have begun new programs to promote the commercialization of research. Many universities now realize that commercial technological innovation and research excellence can be compatible. The generation of new firms by students, alumni, faculty and university-associated groups creates employment opportunities. . . and can attract quality researchers rather than drain them away as is often suggested (p. 6)."

Other groups studying research parks have also pointed to the important role they play in developing the nation's R&D base. The President's Commission on Industrial Competitiveness recommended that the business community:

> "Increase support for university and joint industry cooperative research that meet specific techno-

[19]David N. Allen, "Business Incubators, Assessing Their Role In Enterprise Development," *Economic Development Commentary*, National Council for Urban Economic Development, Winter, 1985, p.6.

logical needs, with the objective of reducing the gap between development and the application of new technologies to manufacturing."

Looking at it from the university side, the Commission further recommended that universities: "Initiate [with industry and government support] research to increase the understanding of management of technical innovation and to improve the methods of analyzing the relationship between manufacturing and research and development."[20]

[20] *Report of the President's Commission on Industrial Competitiveness*, p. 90.

Part 4

Location Factors and the Growth of Research and Development

This study was began with several major assumptions relating to research and development capacity in the United States:

- Despite higher expenditures for research and development the United States is not keeping pace with foreign competition when R&D investment is measured as a percentage of GNP.
- Expenditures for defense-related R&D that have little commercial application are not increasing the R&D/GNP ratio.
- Constrictions in the federal budget will have a negative impact on R&D, particularly on basic research.

Plus other conditions shaping the future:

- There is a lag in industry commitment to new project development.
- Institutions of higher learning will soon be unable to produce the number of science and technology graduates needed to meet the nation's needs. In fact, major universities are training increasing numbers of foreign students who will return to their own countries.

In general, the survey respondents and interviewees, tend to substantiate these assumptions. The solutions offered by a variety of governmental study groups focus on greater involvement by government and business in improving the U.S. competitive position. The Business/Higher Education Forum, an organization of corporate and academic chief executives affiliated with the American Council on Education, in its study on competitiveness, has advocated an increase in federal spending for university research facilities and science education. It also suggested changes in public policy to "encourage long-term investments in state-of-the art R&D and production facilities".[21]

[21] *Toward A Competitive Agenda*, Business/Higher Education Forum, Washington, D.C. January 1985.

Both the President's Commission on Industrial Competitiveness and the Business/Higher Education Forum reports convey a sense of urgency. They emphasize that further effort must be made toward the improvement of education at all levels—with increased attention given to the training of engineering and science majors, whose skills are crucial to continued technological development. Current demographic trends point to the fact that a smaller number of young people will be available to meet the nation's need for trained scientists and engineers. Thus, a higher proportion of tomorrow's graduates must be oriented to these disciplines. At the same time, federal support for research and development (except for defense-related programs) is not increasing at the level established during the past decade. And, given current budgetary restraints, it seems certain that there will be less funds to support university programs.

Some of the recent failures of science-connected projects, such as the space shuttle and the Chernobyl catastrophes may also have lessened public support for high-cost technological programs. And even new advances in biotechnology and genetic engineering, executives say, are being viewed with caution, and the growth of these industries is being slowed by the enactment of a variety of protective regulations.

At the same time, some of the once "hot" high-technology leaders—the computer and electronic component industries—have cooled off as evidenced by lower industry earnings and recent business failures. These industries, it appears, will have a slower rate of growth in the immediate future. This has led some venture capitalists to look elsewhere than to high-technology industries.

Thus, a confluence of many factors is making it more difficult to fund and support the creation of new research and development facilities. This occurs at the precise time that such new resources are regarded as an indispensible element in keeping the United States internationally competitive.

Other Studies On Locational Factors

While The Conference Board survey concentrates exclusively on the factors that determine the location of new research and development facilities for existing companies, previous research has dealt with the location of new high-tech companies. Many of the siting factors are similar.

In 1982, the Joint Economic Committee of the U.S. Congress sponsored a study on *Location of High Technology Firms and Regional Economic Development*.[1] This study focused on nearly 700 high-tech companies. Three-quarters of these were located in California and Massachusetts, and 75 percent employed fewer than 500 people. Special emphasis was placed in this study upon identifying which regions of the country would benefit from the growth of such high-tech industries.

Among the major findings of the JEC study are: High-technology companies are "footloose" in the sense that access to markets and transportation are not major determinants in location decisions. The study also discounted other spatial, environmental or material-supply considerations as site-location factors. However, these factors are acknowledged as important for manufacturing locations.

A second major finding of the study was that "most high technology companies prefer urban to rural environments" (pp. 16-17). The term "urban environment" refers to the clustering of high technology companies in areas judged to have a good public infrastructure (including schools).

The study's author also cited the availability of skilled labor and the local tax climate. In making a regional—as opposed to community—choice, accessibility to, and the quality of, higher education facilities was judged to be a significant factor. In the JEC study factors such as the quality of life and cultural opportunities were relatively unimportant, ranking tenth among twelve factors in one determination and eighth among fourteen factors in a second (pp.22-28).

In 1984, another research study focused on firms in Orange County, California, and looked at the location decisions of 98 high-technology companies. Using a questionnaire patterned after the one developed by the Joint Economic Committee, the University of California study concentrated on companies with a single location. The leading site-selection factors cited by these respondents were the availability of professional and technical personnel, ample space for expansion, and the desire of the owner or chief executive officer to live in that particular area. The availability of good housing stock, the climate, and local economic conditions were also seen to be important factors. Unlike the study by the Joint Economic Committee, the University of California survey viewed local taxes, or financial incentives, as among the least important determinants in site selection.[2]

There are some similarities—as well as some important differences—among The Conference Board, The Joint Economic Committee, and the University of California studies. The California and JEC studies focused on company locations and were more regionally concentrated. Despite differences in the scope of the studies, however, proximity to universities was a highly ranked factor in all three. In the California study, this factor lapped over and became a part of the "quality of life" attributes of a community.

The Conference Board study found less emphasis on tax incentives and financial assistance—particularly among major firms—than did the other two studies. In the Board's study, local property tax considerations are folded into site-acquisition cost and become a part of the overall factor identified as "land and construction costs." In addition, it should be noted that the Board's study included many firms that were able to use land they already owned on which to build R&D facilities.

[1]Robert Premus, Joint Economic Committee of the U.S. Congress, *Location of High Technology Firms and Regional Economic Development*. U.S. Government Printing Office, Washington D.C., 1982.
[2]Craig Galbraith, "High Technology Location and Development: The Case of Orange Country," *California Management Review*, Fall, 1985.

Pinpointing Areas of Growth

The Conference Board survey does point to growth in research and development within particular sectors. For example, R&D operations in small computer and component companies, as well as in large chemical and pharmaceutical firms, outpace the overall rate of R&D facilities growth.

A recent comprehensive examination of the chemical industry, by a panel chaired by Professor George Pimentel of the University of California at Berkeley, identifies five broad areas where "research is most likely to return a high

payoff."[22] This examination finds that new growth in R&D will most likely occur in existing companies and in those states in which these companies are headquartered—or where they already have research installations. In this type of economic climate, communities that are dedicating resources to attracting new research-based and high tech industries may want to reconsider and allocate some of these resources to helping existing employers grow and diversify.

The Conference Board survey also found that a substantial amount of R&D activity occurs in nonmanufacturing companies. With economists forecasting that service industries will generate the largest increases in employment, it is likely that there will be expanded opportunities for research in systems and service delivery. R&D in the service industries also provides opportunities for new collaborations between schools of business and schools of technology together with cooperating corporations.

There is also evidence of a great deal more attention being paid to research on processes rather than on discrete products. The National Science Foundation, during 1985, established 11 engineering research centers in major universities. Early in 1986, former presidential science adviser, George Keyworth, proposed adding $500 million to the funding of basic research to create 50 new technology centers at graduate schools of engineering, similar to the 11 NSF centers. This emphasis upon Federal Government support for technology as well as science underscores a trend toward finding new applications for existing knowledge, and it beckons educational institutions and students toward opportunities for research in engineering and design.

Applying the Board survey findings to these trends in R&D, suggests these impacts on location decisions:

- That small service-oriented research and development companies will be even more "footloose" than small high-tech manufacturers—with some even locating on a temporary basis wherever research is needed. (See box.)
- That larger companies will increase systems applications at headquarters and research on new production technology at plant sites.

Thus, the opportunities for R&D in the future will be available in more kinds of businesses and in more locations nationwide.

[22] *Opportunities in Chemistry*, National Academy Press, Washington, D.C. 1986.

Related Conference Board Publications

The Commercial Development of New Products (1986) 890

Corporate R&D Strategy, Innovation and Funding Issues (1985) 863

Issues in Economic Development, Stimulating Local Leadership and Resources (1985) .. RB175

Research and Development, Key Issues for Management (1983) 842

Urban Plant Siting (1982) RB123

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Factors in Corporate Locational Decisions (1979) IB66